Smart Crop Suitability System

Project ID: 19-015

Requirement Design Document

Author:
C.P. Wickramasinghe – IT16034600

B.Sc. Special (Honors) Degree in Information Technology
Department of Information Technology

Sri Lanka Institute of Information Technology Sri Lanka

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Supervisor:
Dr.Anuradha Jayakody

B.Sc. Special (Honors) Degree in Information Technology
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DECLARATION

We declare that this is our own work and this Design Document Specification does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Author:

C.P.Wickramasinghe
IT16034600

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1. INTRODUCTION

1.1 Purpose

The predominant purpose of this Requirements Design Document (RDD) is to provide a detailed description of the functionalities of the system ‘Smart Crop Suitability System ’. Therefore, this document will cover each of the system’s intended features, as well as offer a preliminary glimpse of constraints and their effects on the system. The document will also cover hardware, software, and various other technical dependencies.

The main motive of this document is to acknowledge the implementation of sensor subsystem of the system. As one of the main parts of the system, a detailed description is presented about the components which assist used in the system. Special features to be added and conclusion made at the end of the literature survey which led to the necessity of the features are discussed. Furthermore, the required duration of the implementation within the time frame and the deliverables to be distributed at the end of the implementation are reported in detail.

1.2 Scope

This document will cover how the proposed system’s main objective Develop the sensor sub system using EC and temperature sensors and establish the entire system for the data communication with the Raspberry Pi. Using the sensor subsystem sensor readings (pH, EC, moisture, temperature) from soil use to develop the algorithm using machine learning.

Algorithm can generate soil nutrients from sensor readings and suggest the most suitable crop considering the main soil nutrients. Such as N, P, K, and environmental factors with ground type (rough, salty, sand) can predict the most relevant crop for the soil. Establish the entire system to data communication with cloud to remote access to all sensor data (pH, EC, moisture, temperature) in soil. check entire system for the errors for the final product. Only 2 sensors were focused in this document.

In addition, the methods used in system's accuracy and efficiency are presented to highlight their importance which is to overcome the disturbance or malfunctions caused when using the system. The hardware components that are expected to be used in the system, the innovative hardware equipment, the user interfaces and the connection between the hardware and UIs are depicted in detail.

1.3 Definitions, Acronyms, and Abbreviations

UI	User Interface
Rasberry Pie 3 B+	Rasberry Pie is an open-source electronics platform based on easy to-use hardware and software.
EC sensor	Measure Electrical conduction in soil.
Temp sensor	Measures temperature in soil/ Environment

Table 1 - Definitions, Acronyms, and Abbreviations

1.4 Overview

The first chapter focused on the introduction to this application. This application is mainly targeted an easy way to realize the most suitable crop that can be grown in a particular land with a fertilizer plan in order to have a successful cultivation and avoid soil degradation due to excess fertilizer usage.

In the second chapter of the document provides overall description of the functionality and interaction with the other component. This section also discusses the interfaces, constraints and operations to provide better understanding of the product. Further it explains characteristics of users, constraints of the system, comparison with an existing product, assumptions, and dependencies, and apportioning of requirements.

From the third section of the document, user specifications, risks of the hardware components, architectural design details are described and maintainability, security and the references are provided at the bottom section of the document.

Our main target audience would be farmers and new cultivators and both second and third chapters are explaining the same product in two different languages since this document uses a different audience.

2. OVERALL DESCRIPTION

Main goal of this system is to select suitable crop to cultivate on desired lands. In order to get suitable crop user need to log in to the system and after the login user need to select ground type from drop down menu. After that user need to enter ground area by perch.
Then app suggest how many readings should get for best results. app will not continue if the suggested reading count does not fulfilled. [1] After selecting, device should insert in to the soil and wait less than a minute to get sensor readings. Sensor sub system get pH, EC(electrical Conduction), Temperature and humidity from relevant sensors. After getting all sensor readings calculate with algorithms in Raspberry pie and send calculated data to cloud server.

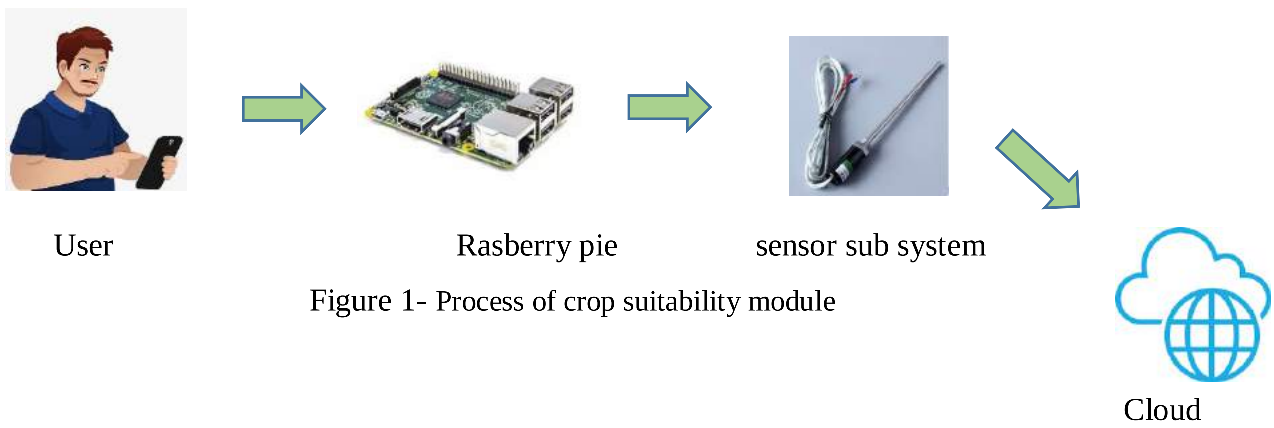

Figure 1- Process of crop suitability module

2.1 Product perspective

There are many types of researches based on predicting the crop growth by using different tools and techniques. According to the researchers Joon-Goo Lee and Haedong Lee, they have used image processing techniques for develop same kind of an app.[2]Also most of the products use either expensive sensors or chemicals for the soil tests. But in this proposed system will develop a tool with attaching sensors which will test the main factors like pH, electrical conductivity (EC) of the soil and temperature, humidity of the air.

The future fertilizer plan will be generated according to the data gathered through sensors with processing in-built data set in the mobile application. Because the in-built data set will store not in the cloud storage, but within the mobile application, the user does not need to download the data set to the mobile phone each and every time when he/she uses the application.

Various systems that cater similar requirements were discovered during the literature survey. After the analysis of the systems discovered, each of them contained few defects and minor weaknesses in the technologies that were used. [3] Since the proposed system serves the accessibility for physically disabled people who would be dumb, this target audience is underprivileged in using the systems operated via speech recognition. Reported below are few of the existing systems that cater insignificant requirements of the proposed system and a brief description of the systems discovered.

2.1.3 Hardware interfaces

- EC sensor

Figure 2 – EC sensor

- Temperature sensor

Figure 3 – Temperature sensor

- Raspberry pie 3 B+

Figure 4 – Raspberry pie 3 B+

2.1.4 Software interfaces

- Raspberry OS

2.1.5 Communication interfaces

- Wi-Fi
- Bluetooth
- HDMI
- Ethernet
- USB

2.1.6 Memory constraints

The system is expected to use no more than 1 GB of Ram and 8 GB of external Storage.

2.1.7 Operations

- User should enter area of the ground.
- Ground details and sensor details should store in the cloud.
- Data processing will done by Raspberry pie.
- User has the ability to find solutions for the issues of the crop.
- Mobile application should display generated output to the user.
- For the internet facility, mobile data or wifi should be enabled.

2.2 Product Function

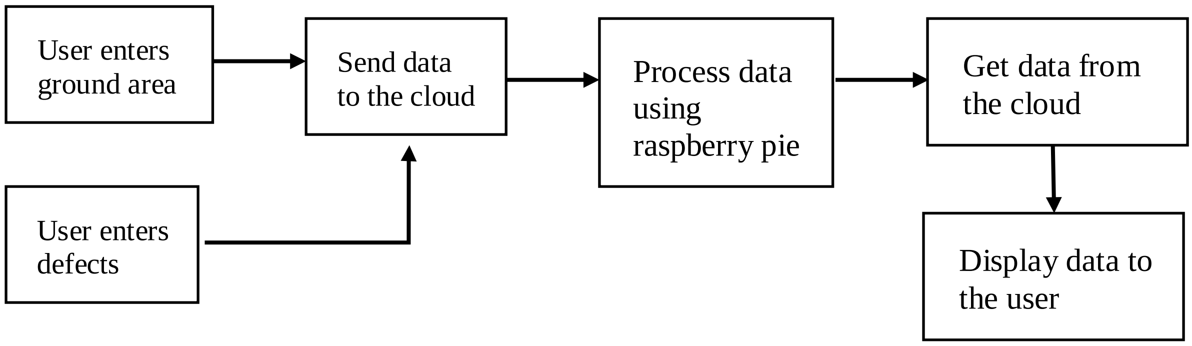

Figure 5: High level diagram of product functions

- User enters ground area
  User enters the area of the ground which he/she planning to process the cultivation.

- User enters defects
  User enters any defects while occurs in the growing period of the crop, in order to find the accurate solutions.

- Send data to the cloud
  Cloud storage will be used to store the data user entered for the future calculation processes.

- Process data using Raspberry pie
  Raspberry pie board will be used for data processing using machine learning algorithms. The processed data will be send back to the cloud through an API.

- Get data from the cloud
  Get processed data from the cloud in order to display to the user

- Display data to the user
  User can view the processed data through the mobile app.
  - Future fertilizer plan.
  - Notifications.
  - Solutions for the defects.

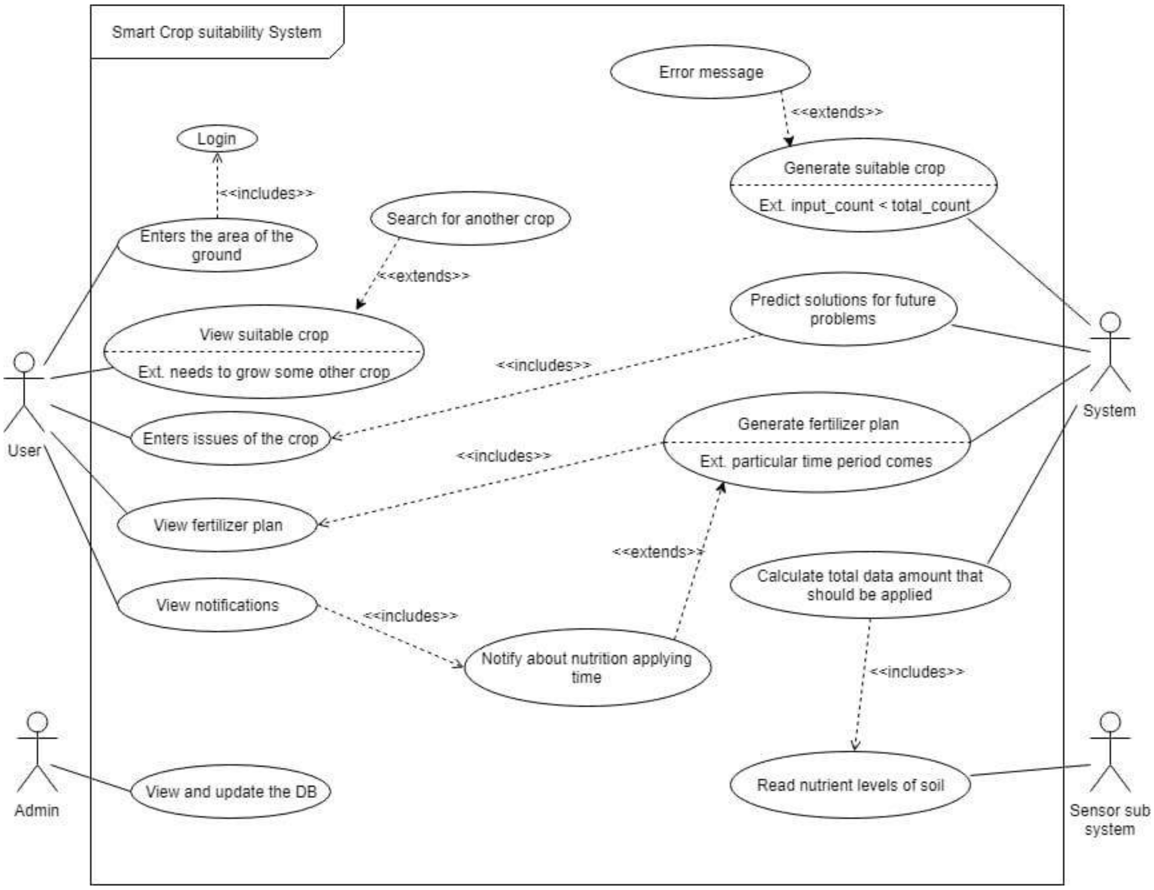

Figure 6 – Use case diagram

Use Case Scenario

Use case 01	Select suitable crops to cultivate on desired lands
Primary Actor	System
Pre-condition	Soil should be wet in order to get readings from soil.
Main success scenario	1. User clicks on "Generate suitable crops"
Extensions	Then app suggest how many readings should get for best results. app will not continue if the suggested reading count does not fulfilled.

Table 2 – Use case Scenario

2.3 User characteristics

The “smart crop suitability system” product mainly depends on the mobile application and a tool with sensor hardware components. Because of that, the user must have the minimum knowledge to use a smartphone, use the sensor tool, basic knowledge of cultivation and fertilizers and English language skills. Because of this Product is based on cultivation, mainly target the farmers who have main idea about using smart devices.

2.4 Constraints

- A smartphone is required with enough battery life.
- For the communication between smart crop suitable system tool and the smartphone, required wifi connectivity enabled in a smartphone.
- For the communication between the smartphone and the database, required internet connectivity enabled in the smartphone.
- Android used, for the mobile application development,
- Cloud data base is used to store data to retrieve in relevant points.
- With the limited phone memory, the application should be able to run without any effect on the other operations and the processing speed.
- Raspberry pi3 model b+ board is required to use and some data is going to be stored in there.

2.5 Assumptions and dependencies

- The smart phone is switch on throughout the day as well as have the enough power of battery.
- The WIFI connectivity and the internet connectivity always enabled in the smart phone.
- Mostly the smart crop suitability system is used by people who have basic knowledge about fertilizers and cultivation.
- The information (ground details & details about fertilizer levels) which is provided by the user is correct
- Soil samples taken by zig zag method.
- Soil samples will get an average fertilizer level of whole ground.

2.6 Apportioning of requirements

For used this “smart crop suitability system”, first user must download “smart crop suitability system” mobile application from the google play store. After the install the application. after download the application user can provide details of user for the registration process and after registering process complete up user can log to the system using relevant credentials.

After the login and configuration, user mainly direct to the home page. In here user can visible some tips of cultivating. Additionally, user can select main functions of the system (Recommend the best crop, Recommend the fertilizer usage, Suggest the future fertilizer plan).

User have to enter relevant data to particular functions such as stage level of crop, select the user defined crop.

3 SPECIFIC REQUIREMENTS

3.1 External interface requirements

3.1.1 User interfaces

1. Sign up – As the first step, user has to sign up with the mobile application.
2. Create an account – If the user doesn't have an account, then this interface will give facility to create an account within simple steps.
3. Login- using user credentials user can log in to the system.
4. Home page-Through this interface user can view cultivating tips and redirect to the other main functions using buttons.
5. Recommend the best crop interface-Through this interface user can view the best crop recommendation for the ground fertilizer level by analyzing the data set which get by the tool.
6. Recommend the fertilizer usage interface-Through this interface user can view the recommended fertilizer by providing the selected crop
7. Suggest the future fertilizer plan interface-Through this interface user can view future plans and fertilizer levels according to the plant stage.
8. Fertilizer level indicating alert-in this interface app showing the current fertilizer level of the soil by retrieve data set from the tool.
9. User Details view interface-In this interface user can view details of the user account.

3.1.2 Hardware interfaces

As there are several objectives to achieve the final product feature, some hardware components are going to be used to satisfy those. Those hardware components are,

- Ph sensor -to identify ph level of the soil
- Temperature sensor -to identify the temperature of the soil
- Humidity sensor -to identify the water level of soil
- Electricity conductivity sensor-to measure ability to conduct electricity
- Smart phone - for the mobile application, suggest crops, show locations and user will be notified through the mobile. (Android version 6.0 or higher)
- Raspberry bi 3 model b+ –as the sensor hub

With all these hardware components and parameters, this proposed product will able to be more effective and accurate.

3.1.3 Software interfaces

Some software interfaces have to be used in this proposed system and they can be simply categorized with the relevant function and it will be able to understand clearly. Those are,

Test soil sample and show the details of the soil by fertilizer wise: raspberry desktop application will be used to configure sensors.

Android Studio will be used to implement the mobile app.

Google map API will be used for notifying the user about the soil state of the land according to the locations.

Identify the user: To configure the database with the mobile application, developer need the “Firebase” web application.

3.1.4 Communication interfaces

Mainly in this component the communication process will be happened through the WIFI connectivity. Therefore, raspberry pi and phone is connected always to retrieve data. As well for the communication between the application and database, and for crowdsourcing, internet facility should be enabled.

Moreover, the smart crop suitable system will get the current location using GPS module.

3.2. Architectural Design

3.2.1. High level Architectural Design

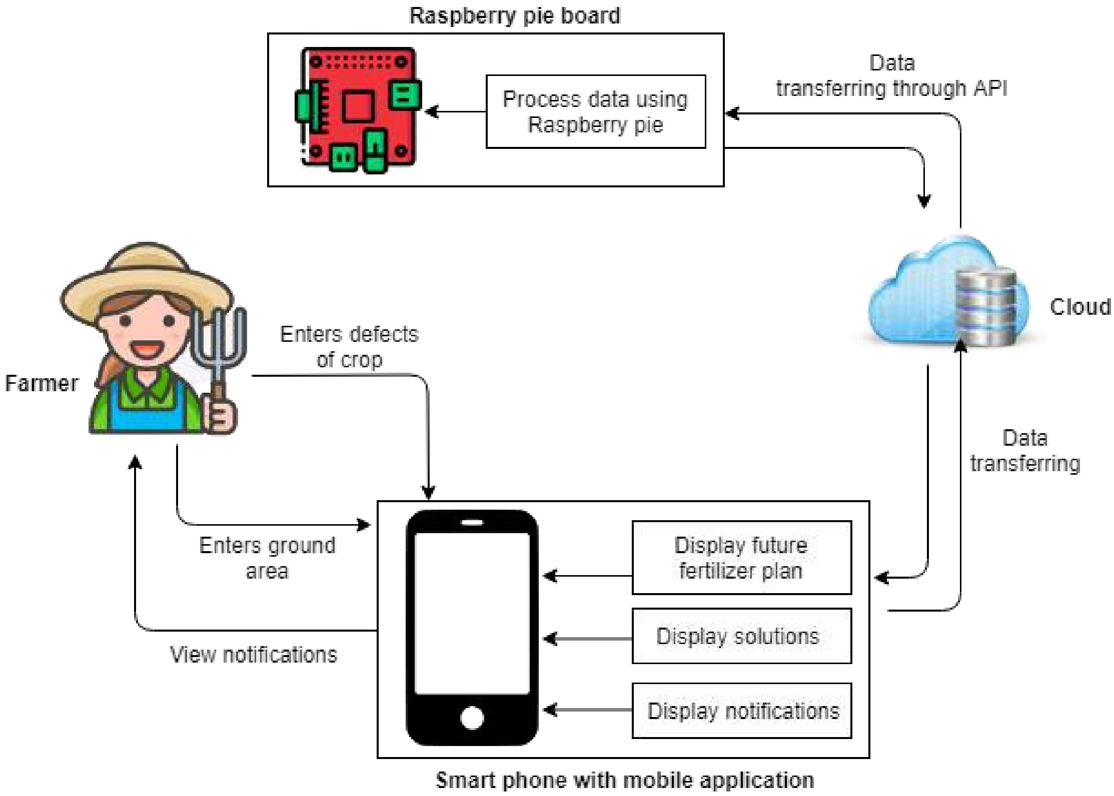

Figure 7: High level architectural design

3.2.2 Hardware and Software requirements with justification

As our proposed product will address to a common issue for human life the final outcome should be more effective and accurate. Therefore, several software and hardware components have to be used for achieving this.

To satisfy each and every requirement, several hardware components will be used such as,

PH sensor and humidity sensor will be used for checking the quality of water. PH sensor checks the water's pH value and it should be between 6.5 and 7.5. humidity sensor will be used for checking the vapor of soil.

GPS module uses for getting the current location it will send to the mobile phone using WIFI technology.

For the communication process among smart phone and smart device, a WIFI module is required to use.

As well, for the developing process, a raspberry board will be used at the bottom of the smart device.

With all these hardware components the proposed product will be an effective product for the human life.

3.2.3. Risk mitigation plan with alternative solution identification

Risk	Impact	Likelihood (%)	Mitigation Plan
pH Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
Humidity Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
temperature Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
EC Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
If there no network coverage in this place	1	50%	Save the data mobile phone and after available network saved in the database
Machine learning algorithm result is less accurate	3	30%	Train the algorithm using more data sets

Table 3: Risk mitigation plan

3.2.4. Cost benefit analysis for the proposed solution

Description	Quantity	Price (Rs)
Ph Sensor	1	350.00
Humidity sensor	1	350.00
Temperature Sensor	1	200.00
EC meter	1	450.00
HDMI to VGA adaptor	1	1225.00
Raspberry Pie 3 kit	1	7450.00
Screen for raspberry pi	1	1400.00
Memory card 16GB	1	1500.00
	Total	**12925.0**

Table 4: Cost benefit analysis

3.3. Performance requirements

It is expected that the proposed system will perform all the requirements stated under the functional requirements section. Some performance requirements identified are listed below.

- The sensor readings must be accurate and trustworthy.
- The mobile application performance is going to depend on mobile phone's battery life, RAM and internet connectivity.
- Sensor details can transfer within less than one second.
- The system will operate with minimum 1GB RAM.

3.4. Design constraints

This product is focused on people without any age limitation, the user interfaces of the mobile application have to be simple, attractive as well as user-friendly. Therefore, people will be able to work with the proposed product easily and effectively with the use of these designed user interfaces.

3.5. Software system attributes

3.5.1. Reliability

As this product address a common issue of people who has an interest in cultivation, the reliability of the proposed product is important. According to this research component,

- The sensor readings must be 100% accurate because most important actions will be based on them.

- To data communication between cloud, internet connectivity should be enabled.

- The system will be tested using several techniques to make sure it’s probability of failure is very low value.

- If there will be a failure in the system a proper mechanism is going to be implemented to show the failures.

- At a time of failure, there should be a way to overcome through that immediately.

3.5.2. Availability

- Always servers need to be available because this system functions working with server data.
- This application should be a real-time application. It is working with real-time data.
- When a user needs mobile phone reset or changes the mobile. We are going to implement the backup option to recover user details.
- The sensor sub system and the mobile application should be easily understandable to users and it should be real time

3.5.3. Security

For user sign up for the mobile application, unique email address or phone number needs to be used by the user. The login details of the user will be sent to the database in the encrypted version. Therefore, user details and other personal details will be secured.

3.5.4. Maintainability

The sensor sub system will be used to get the data through sensors. Other algorithms and functions to process the accurate results will be handled by using the Raspberry pie board and the cloud server. Therefore, if any change occurs in the system, it will be easier to maintain that situation by using an application update or changing the server data.

REFERENCES

[1]. J. G. Lee, H. Lee, and A. Moon, “Segmentation method of COI for monitoring and prediction of the crop growth,” *Int. Conf. ICT Converg.*, no. 2, pp. 640–641, 2014.

[2] S. Aswathy, S. Manimegalai, M. M. R. Fernando, and J. F. Vijay, “Smart Soil Testing,” pp. 41–44, 2018.

[3]. S. Pudumalar, E. Ramanujam, R. H. Rajashree, C. Kavya, T. Kiruthika, and J. Nisha, “Crop recommendation system for precision agriculture,” *2016 8th Int. Conf. Adv. Comput. ICoAC 2016*, pp. 32–36, 2017.